DRAFT CONCEPT PAPER

SUMMARY OF STAFF'S PROPOSED PROGRAM TO MINIMIZE EMISSIONS OF HIGH GWP REFRIGERANTS FROM STATIONARY EQUIPMENT

I. INTRODUCTION

The California Global Warming Solutions Act of 2006 (AB 32, Nunez, Statutes of 2006, chapter 488) directs the Air Resources Board (ARB or Board) to develop early actions to reduce greenhouse gases as part of the State's efforts to reduce emissions to 1990 levels by 2020. A number of the early action measures recommended by the ARB pertain to control of gases with high global warming potential (GWP). These gases are used in a number of applications, with refrigeration and air conditioning among the most important for society and the economy, and the most emissive.

High-GWP gases are used as refrigerants in a wide variety of stationary air-conditioning and refrigeration equipment. High-GWP refrigerants include chlorofluorocarbons (CFCs) and hydrofluorocarbons (HCFCs), classes of ozone depleting substances (ODS) that are regulated under the U.S. Clean Air Act. Hydrofluorocarbons (HFCs) are non-ozone depleting substitutes, but like the CFCs and HCFCs, are potent global warming gases. Staff has developed this concept paper as part of ongoing interactions with interested stakeholders regarding possible regulatory measures. The objectives of these measures would be to minimize emissions of high-GWP refrigerants by requiring:

1- Reducing leaks in existing refrigeration and air-conditioning systems.
2- Improving service practices that maximize reclamation and recycling of refrigerant.
3- Using safe disposal practices that provide for refrigerant recovery from systems and storage containers.
4- Using best practices design and installation of new refrigeration and air-conditioning equipment to minimize potential leaks (and optimize energy efficiency).

II. EXISTING REGULATIONS

Under Section 608 of the Clean Air Act, the United States Environmental Protection Agency (US EPA) has established regulations (40 CFR Part 82, Subpart F)[1] that:

- Prohibit the intentional release of ODS refrigerants and their substitutes during service, maintenance, or disposal of air-conditioning or refrigeration equipment;

[1] All rules, regulations, and federal register citations may be found at the US EPA website:
http://www.epa.gov/ozone/title6/overview.html
http://www.epa.gov/Ozone/title6/608/608fact.html

- Require repair, retrofit, or replacement of equipment with a charge greater than 50 pounds that leak in excess of 35% of the total refrigerant charge for commercial and industrial refrigeration and 15% for air-conditioning applications.
- Set certification requirements for recycling and recovery equipment, technicians and reclaimers.
- Restrict the sale of refrigerant to certified technicians.
- Require persons servicing or disposing of air-conditioning and refrigeration equipment to certify to US EPA that they have acquired recycling or recovery equipment and are complying with the requirements of the rule.
- Establish safe disposal requirements to ensure removal of refrigerants from goods that enter the waste stream with the charge intact (e.g., motor vehicle air conditioners, home refrigerators, and room air conditioners).

While it is illegal to intentionally vent any refrigerant, whether it is a CFC, HCFC, or an HFC, US EPA estimates that there are significant and preventable emissions of these high-GWP gases from refrigeration and air-conditioning systems due to improper maintenance, service, and disposal practices, and the continued reliance on older, inefficient equipment (EPA, 2008).

The South Coast Air Quality Management District (SCAQMD) requires refrigerant use reporting, in addition to the federal record-keeping requirement, for systems containing more than 50 lbs of an ODS.

There are no federal or State requirements to control or track emissions of other high-GWP gases including ODS and HFCs used in foam, solvent, aerosol, and fire suppression applications, or perfluorocarbons (PFCs) and sulfur hexafluoride (SF_6).

III. MAJOR TOPICS FOR DISCUSSION

The sections below provide initial descriptions on various options under consideration, along with some of the questions for stakeholders to address.

A. Applicability

Both the current federal Section 608 regulations and the SCAQMD Rule 1415 requires leak repair and data tracking for owners and operators of stationary and air-conditioning systems that contain more than 50 pounds of ODS refrigerant. Facilities with systems with capacities of this size would include supermarkets, refrigerated warehouses, food processing and other manufacturing operations, and commercial office buildings and other large institutional buildings (e.g., schools, hospitals, military bases, etc.) with chillers and other large air-conditioning equipment.

Staff is proposing that a statewide refrigerant management regulation maintain the same 50-pound threshold used by federal and SCAQMD regulations. Options include:

1) a lower threshold to account for newer technologies with lower charge sizes, for example, roof top air-conditioning equipment for commercial buildings that are as small as 15 pounds, or walk-in coolers used in restaurants or supermarkets with 30 pound refrigerant charges; and

2) a staggered implementation schedule to allow facilities with smaller equipment to comply over a longer period of time compared to facilities with larger equipment. For example:

- facilities with systems greater than 600 pounds of high GWP refrigerant would need to begin monitoring and leak repair by January 1, 2010
- facilities with systems between 200 and 600 pounds of high GWP refrigerant would need to begin monitoring and leak repair by January 1, 2012
- facilities with smaller systems between 50 and 200 pounds would be required to commence monitoring and leak repair by January 1, 2014.

Discussion:

The goal is to maximize emission reductions across all air-conditioning and refrigeration equipment. While leaks and ruptures of large equipment will result in larger refrigerant emissions compared to smaller equipment, there is concern that smaller equipment may have high leak rates that go undetected and can also account for significant emissions.

There is also concern that a lower threshold would impact tens of thousands of facilities in California with smaller equipment, e.g., small office buildings, convenience stores, bars and restaurants, etc. These additional facilities would have difficulty complying with the various leak repair provisions described below, and ARB and air districts could have difficulty implementing the measure due to the large number of facilities.

Available data indicate that building chillers represent a significant high-GWP refrigerant emission source in California (Clodic, 2008). Average leak rates in smaller rooftop air-conditioning units range between 5% and 10% but the numbers of these units are in the tens of thousands which could amount to significant total emissions that could be prevented.

Questions regarding options:

- Is a 50-pound refrigerant charge for a system an appropriate regulatory threshold?
- If not, would 15 or 30 pounds, or a larger size, be a more appropriate threshold for air-conditioning and refrigeration systems?
- Should ARB have different thresholds for refrigeration vs. air-conditioning systems?

- Should ARB only regulate refrigeration systems?
- Should ARB have a higher threshold for air-conditioning systems? For example, only building chillers over 600 pounds would be subject to the rule, but smaller air-conditioning equipment with over 50 pounds of high-GWP refrigerant would be exempt?
- Should ARB provide additional time for facilities with smaller equipment to comply with the various regulatory requirements, and if so, what would be an appropriate schedule?

B. Leak Repair

Data collected by the SCAQMD indicate that on average, approximately 20% of ODS refrigerant leaks from stationary refrigeration equipment (Dean, 2008). Given the cost savings that owners and operators of equipment could realize with preventative maintenance and improved containment, staff believes that leak monitoring and leak repair not only has significant environmental benefits but also is sound economic practice.

Recent regulations established by the European Union require that facilities with equipment with refrigerant charges greater than 300 kilograms (660 pounds) have continuous leak detection[2]. Under the EU regulations, the frequency of leak testing for smaller equipment varies based on charge size, as summarized in the following table:

EU Monitoring Requirements for Refrigeration/Air-Conditioning Systems

Frequency	**Normal systems**	**Hermetically sealed systems**
None	< 3kg	< 6 kg
Annual	3 – 30 kg	6 – 30 kg
6 Month - (annually*)	30 – 300kg	30 – 300 kg
Quarterly - (6 months*)	> 300kg	> 300 kg

*Frequency of checks can be halved where leak detection system is in place.

If a leak detection system is fitted to any plant below the mandatory 300 kg threshold the frequency of leak testing can be halved, although an annual check remains the minimum frequency.[2]

Staff is proposing the following requirements for owners and operators of stationary refrigeration and air conditioning systems with refrigerant charges greater than 50 pounds:

[2] Guidance for Departments on the Regulation of Fluorinated Greenhouse Gases (F-gas) and University Equipmenthttp://www.gla.ac.uk/seps/documents/Guidance_Fgas_Final.pdf, retrieved July 10, 2008.

- A facility with a refrigeration or air conditioning system with a high GWP refrigerant charge greater than 600 pounds install and maintain an automatic leak detection system;
- A facility with a refrigeration or air conditioning system with a high GWP refrigerant charge greater than 50 pounds must conduct an annual audit to confirm operational parameters within manufacturer's specifications and that there are no refrigerant leaks;
- Any leak in refrigeration or air conditioning equipment must be repaired within 7 days of detection;
- A system with a high GWP refrigerant charge greater than 600 pounds with components or other equipment that is repaired must be re-tested no sooner than one day, but within 30 days after repair;
- Only technicians that have US EPA certification to service air conditioning and refrigeration equipment are permitted to complete repairs;
- No technician is permitted to top off an air conditioning or refrigeration system with additional high GWP refrigerant unless a repair, or an attempt at a repair, is performed.

Discussion

Despite the costs associated with refrigerant losses, many businesses have apparently determined it to be more economic to top off leaky systems rather than pay for repairs. This determination should change as the price of refrigerants increase, but there is no guarantee that facilities will have the necessary monitoring and other data to make an informed decision.

There are additional issues that arise in designing leak repair requirements that are effective, practical, fair, and enforceable. For example, many large facilities have continuous refrigerant monitoring, but the economic return for different facility and equipment categories is not well documented. There is also a question of whether intermittent (e.g., annual) leak audits are an effective means of maintaining system performance and preventing leaks, especially given that considerable emissions are attributed to sudden line ruptures that result in complete release of refrigerant charge.

There is a concern that the allowable leak rates under the federal regulation are outdated and result in emissions that could be readily prevented. Staff's consideration to require leak repair for any leak is based on the presumption that any leak can impair system performance and represent an economic drain, and that should be corrected.

Another issue is that while leak tests are commonly done immediately following a leak repair, usually on the component(s) or part of the system(s) that is repaired, there is a question as to whether such testing adequately measures whether there are other leaks across the full system. Given the expense involved in monitoring and in leak repair, it is important for equipment owners and operators to conduct

verification tests on the full system when the equipment is operating under normal conditions. One concern however is the expense in having a technician return to the facility for a follow-up verification a day or a week after the repair was made, and whether an immediate (same day) verification test is sufficient.

The proposed requirement for technician certification is intended to insure that technicians who are properly trained do all servicing of air-conditioning and refrigeration equipment, regardless of the system size. While the US EPA certification currently does not include testing on knowledge or skills pertaining to HFC refrigerants, ARB anticipates that the US EPA training requirements will be updated in the next year and that knowledge of ODS equipment and refrigerants are sufficient at this time to insure responsible servicing across all high-GWP refrigerants.

Questions regarding options

- Should larger systems be required to have continuous leak detection systems?
- Are such systems viable, and if so, is 600 pounds, based on the EU regulations, a reasonable threshold?
- Is an annual leak detection audit an appropriate requirement for facilities with smaller systems?
- If not, what would be the appropriate frequency for smaller systems?
- Should ARB adopt allowable leak rates similar to the federal regulations (e.g., 35% on an annual basis), or is it appropriate to require repair of any leak regardless of the intensity?
- Is requiring a verification test after at least one day after the repair is completed reasonable for facilities with very large systems (over 600 pounds)? Are there surrogate testing procedures that could be employed by the facility to negate the need for a technician, while providing the facility with assurance that the repair was effective?
- Is a prohibition on topping off without first making a repair or a repair attempt reasonable, and how would ARB or the Districts enforce such a prohibition?

C. Maximize Reclaim and Recycling of Refrigerant

In the U.S., refrigerant recovery and recycling equipment, certified by industry and US EPA standards, is widely used to remove refrigerant from equipment, separate oil and other contaminants, and store the refrigerant temporarily while the system undergoes service or disposal. Because of incompatibility of different types of equipment with different refrigerants, and the growing diversity of refrigerant blends used in different sectors, different types of recovery/recycling equipment and storage containers are often needed in the field.

There are indications that because of relatively low prices, the amount of refrigerant that is recovered from equipment and reclaimed is low. For example, based on a September 2006 revised draft report from the US EPA, titled, “The U.S. Phase-out of

HCFC Projected Servicing Needs in the U.S. Air-Conditioning and Refrigeration Sector," DuPont estimates the amount of R-22 reclaimed by EPA-certified reclaimers has been less than 10 percent." [3] It is important to note that this does not include refrigerant that is recovered on site and reintroduced into the same system or a different systems owned by the same entity.

To reduce the amount of high-GWP refrigerant that is either vented during or after equipment servicing, and increase the amount of refrigerant that is reclaimed and put back into the marketplace, staff is considering that the following businesses submit annual reports to the ARB and/or air districts with the following information:

- Technicians
    - The amount of high-GWP refrigerant purchased.
    - The amount of high-GWP refrigerant recovered from equipment.
    - The amount of high-GWP refrigerant returned to equipment.
    - The amount of high-GWP refrigerant sent for reclamation.
    - The distributor and reclaimers where refrigerant was returned.

- Reclaimers
    - The amount of high-GWP refrigerant received from technicians.
    - The amount of high-GWP refrigerant reclaimed to specifications and sold back into the market.

- Refrigerant Distributors
    - The amount of high-GWP refrigerant sold.
    - The amount of recovered high-GWP refrigerant received from technicians and sent for reclamation.

- Facilities (owners/operators of air-conditioning and refrigeration systems with more than 50 pounds of high-GWP refrigerant)
    - The amount of high-GWP refrigerant purchased.
    - The amount of high-GWP refrigerant put into equipment.
    - The amount of high-GWP refrigerant recovered from equipment.
    - The distributors and reclaimers where refrigerant was returned.

Facilities would be required to submit supplemental information as part of their annual report, including the type and size of equipment, the kind of high-GWP refrigerant(s) used, the technician(s) that service their equipment, and the their total facility energy use.

Discussion

[3]Powell, P. Refrigerant Costs, Shortfalls to Spur More R-22 Reclaim, http://www.achrnews.com/Articles/Article_Rotation/BNP_GUID_9-5-2006_A_10000000000000278185, retrieved July 10, 2008.

Under current federal regulations, system owners and operators are only required to maintain records on the amount of ODS refrigerant they purchase and place into their equipment. Similarly, under SCAQMD Rule 1415, facilities only report on ODS refrigerant purchased each year. The reporting requirements being proposed are intended to promote responsible life cycle management of high-GWP refrigerants.

The annual report would be a summation of individual jobs and transactions that should be recorded by all of the entities under normal business practice. The information received would be used by the ARB and/or the air districts to identify wide discrepancies in the amounts of high-GWP refrigerants entering, leaving, and being recycled back into the market.

In addition to the additional reporting for businesses, another concern is how refrigerant sales and transactions outside the state border would be accounted for. Technicians and reclaimers would be asked to provide information only on refrigerant recovered from, and put back into, equipment in California. Nevertheless, ARB expects that the quantities reported that reflect out of state transactions will be relatively low.

Questions regarding options

- Should technicians be required to report on the amount of refrigerant they handle, or should the reporting onus be exclusively on their customers (equipment owners)?
- If so, would ARB be able to determine with confidence if high-GWP refrigerant is being reclaimed?
- Is it adding unreasonable burden on technicians, reclaimers, and distributors to require annual reports with information the affected businesses are already collecting?
- Should ARB be considering other requirements to increase recovery and recycling of high-GWP refrigerant?

D. Safe Disposal

EPA regulations require that ODS refrigerant be recovered from equipment prior to disposal (or servicing) of the equipment. Compliance for most household appliances is considered to be relatively low (EPA, xxx). Staff proposes that this requirement be extended in California to all high-GWP refrigerants; ARB will be working with the U.S. EPA to expand enforcement of this “no venting” prohibition.

In the U.S., refrigerants for servicing commercial and residential equipment are typically transported in 30-pound cylinders. Once those cylinders are emptied, they may be returned to the distributor. But, more often they are disposed of at a landfill. These “empty” cylinders may retain several pounds of refrigerant “heel” that can go

unnoticed and as a result is released to the atmosphere when the cylinder is crushed for disposal.[4]

Staff estimates that up to 0.26 $MMTCO_2E$ of high-GWP refrigerants in cylinder heels may be released each year.

There are a number of options to address this issue. One is to use refillable cylinders that can be repeatedly "topped off" rather than discarded. The EU F-gas regulations prohibit the use of so called "1-way" cylinders, thereby requiring the use of refillable cylinders.

Another option is to prohibit disposal of cylinders without its contents completely evacuated under a vacuum, and the refrigerant reclaimed. This would mean that prior to disposal a cylinder would have to be first sent to a certified reclamation facility so that the contents can be recovered.

Staff is also considering a requirement that sale of high-GWP refrigerant in non-refillable (DOT-39) cylinders must include a deposit for return of the cylinder. The intent is to incentivize technicians to return the empty tanks to the distributors who would return the deposit. Such a program would be similar to a deposit program that ARB is considering for small (12 and 16 ounce) cans of high-GWP refrigerant sold in retail stores for recharging automotive air-conditioning systems.

Finally, the staff is proposing that any business selling more than 2,000 pounds per year of high-GWP refrigerants must meet a refrigerant reclamation goal as follows:

- In 2012, 20% of total sales by refrigerant
- In 2015, 30% of total sales by refrigerant
- In 2020, 50% of total sales by refrigerant

Discussion

The EU prohibition on 1-way cylinders has only recently been adopted so it is too soon to judge its efficacy. There are a number of concerns however associated with a system that mandates refillable cylinders. First, refillable cylinders are required to have unique valves that can be removed and replaced with each re-fill. There are currently few if any cylinders made in the U.S. fitted with such valves and it is uncertain how fast a transition to new cylinders could occur. Second, because the cylinders would be re-used multiple times, the currently used DOT-39 non-refillable cylinders, which have relatively thin walls, would not be sufficiently strong. Third, refillable cylinders are much heavier than non-refillable cylinders, which may lead to increased worker injuries or time requirements to complete jobs. Finally, refillable cylinders may have to be designed to carry smaller quantities of refrigerant, thereby resulting in few cylinders per truck load and more vehicle miles travelled.

[4] Much larger tanks with hundreds of pounds of refrigerant are used to service industrial refrigeration equipment. Refrigerant in these cylinders are completely evacuated under a vacuum.

If refillable cylinders are required, then thicker-walled cylinders would have to be manufactured. In the short term this would require additional steel (and associated greenhouse gas emissions along with other indirect environmental impacts), but in the long term, the refillable cylinders would replace the annual manufacturing of non-refillable cylinders resulting in reduced manufacturing of cylinders.

Refillable cylinders may lead to increased worker injuries or time requirements to complete jobs. Refillable cylinders can be as much as 10 pounds heavier than non-refillable cylinders, so technicians may have increased injury resulting from carrying the heavier cylinders. Alternatively, cylinders can be manufactured to be lighter, but this would require the cylinders to be charged with less refrigerant to avoid imposing additional weight requirements on technicians.[5] As a result, fewer cylinders and less refrigerant would fit on service trucks, resulting in more trips and potentially more time to complete jobs.

Another potential issue is the infrastructure that may be required to refill cylinders. Facilities that could serve as re-fill centers would have to be located throughout the State to ensure that technicians have easy access. Such centers do not currently exist and it is uncertain how quickly such infrastructure could be established.

There are a number of concerns associated with a cylinder deposit program such as the appropriate deposit amount, the fate of uncollected deposits, and how funds are transferred between distributors if a technician returns a cylinder to a different location than where it was purchased. One option is for ARB to establish a minimum deposit amount, for example, 25% of the value of the refrigerant in the cylinder, or 100% of the cost to replace the cylinder. For example, if a cylinder contains refrigerant priced at $100, the deposit required of the technician would be at minimum $25. Alternatively, if it costs $100 to replace a cylinder that is not returned, then the deposit would be $100. The amount would be subject to review and modification as ARB collects data on the program's effectiveness.

The intent of the reclamation targets is to incentivize the recovery and recycling of bulk quantities of refrigerants (not just the cylinder heels). The targets would apply to refrigerant distributors as well as reclaimers. It is estimated that between 2 and 10% of HCFC-22 is being returned for reclamation. While some of the refrigerant may be recovered on site and reintroduced into the system, there have been high levels of virgin HCFC-22sales, which suggests that a significant amount of recovered refrigerant is either being lost or vented, or stored for future use.

<u>Questions regarding options</u>

- Should an EU-type of cylinder prohibition be adopted in California?
- If so, how could ARB insure that it would be implemented so as to not impede technician operations?

[5] Possibly 22-25 pounds of refrigerant compared to the current 30 pounds in a conventional cylinder (reference)

- If so, how could ARB insure that out-of-state, non-refillable cylinders are not used in California?
- Should ARB set a deposit minimum and if so, would an appropriate starting point be 25% of the refrigerant value in a cylinder? 50%? 100%
- Should refrigerant distributors be allowed to keep uncollected deposits?
- Are the proposed reclamation targets necessary, or will increasing prices for virgin refrigerant create sufficient incentive for technicians to properly recover and recycle refrigerants?

E. General Requirements for Refrigeration and Air-Conditioning Systems

Based on data from SCAQMD, supermarkets, food processing facilities, and refrigerated warehouses account for the highest levels of refrigerant emissions from stationary sources. As such, one of the early action measures recommended by ARB focused on specifications for new equipment used in commercial food refrigeration. The proposed regulation will address improvements in both existing and new facilities.

1. Repairs or Modifications to Existing Systems

Refrigeration and air-conditioning systems are designed as sealed units to provide long-term operation, and manufacturers have defined minimum tightness requirements to guarantee permanent operations during defined periods. Despite best efforts to design tight systems that will not leak, component parts and the many connections within a system develop leaks over time, attributable to various causes (RTOC, 2006):

- Tightness degradation due to temperature variations, pressure cycling, vibrations, copper lines rubbing together, and normal expansion and contraction that can lead to unexpected and significant increases of leak flow rates.
- Component failures from poor construction or faulty assembly.
- Improper installation that fail to create tight joints, use proper piping materials, or test for component defects.
- Improper servicing such as leaving a valve cap loose.

In addition to leak inspections and repair discussed above, ARB staff believes that relatively simple design modifications, and insuring that new components installed into existing systems are of the highest quality, can significantly reduce refrigerant leaks, as illustrated in the following examples from Estberg (2008):

- Compressor racks should be reinforced to prevent vibration being transmitted to the tubing.
- Compressor discharge lines should be type K copper tubing and clamped to eliminate vibrations.
- Use of heavier copper tubing (0.040 inches versus 0.023 inches) in condensers and evaporators can withstand vibrations, contraction and expansion.

- Re-routing electrical wiring in refrigerated cases (e.g., deli, fish) so that it does not come into contact with refrigerant tubing can prevent line breaks from electrical shorts.
- Valves should have tethered caps and all caps should have a triple “O” ring seal.
- All stem packing on valves should have a three O ring packing with an adjustable packing nut.
- All O rings must be resistant to refrigerants and oils.
- No flare nuts for expansion valves or other components should be allowed.
- Stem tubes on solenoids, and hot gas valves should be made of thicker stainless material.
- Solenoids should be manufactured as a single unit.
- Expansion valves and other components in refrigerated cases should have a metal support to prevent vibration during shipping and operation.
- All copper piping should have a plastic or non-corrosive insulation barrier.
- Pipe supports should be installed at no more than 8-foot intervals.

To help insure that the highest quality materials and installation and service practices are followed, staff proposes that any new components installed into refrigeration and air-conditioning systems meet ASHRAE Standard 147 (Reducing the Release of Halogenated Refrigerants from Refrigeration and Air-Conditioning Equipment and Systems, ANSI/ASHRAE Standard 147-2002). This standard is being expanded and updated, and is currently under review by technical committees. A new Standard 147 is expected to be finalized in 2009. This standard will not only specify design and manufacturing standards for new refrigeration and air-conditioning equipment and components, it will establish best criteria for installation, servicing, and decommissioning.

The US EPA GreenChill program is incorporating ASHRAE 147 standards along with other specifications into best practice guidelines for supermarkets. Another option is that GreenChill best practice guidelines be followed by supermarket equipment manufacturers and technicians operating in California.

Prior staff documents presented options for energy efficiency improvements in existing retail food systems, such as enclosing display cases with glass doors or night curtains. ARB is working with the California Energy Commission on modifications to California Building Code, Title 24, that will address energy efficient improvements for commercial food refrigeration equipment and is therefore not proposing technologies specific to energy efficiency improvements in existing systems at this time.

2. New Facilities

ARB has sponsored extensive research into specifications for equipment and components that are available for new facilities, especially supermarkets (Clodic et al., 2008). A number of options have been identified in prior documents made available to the public (ARB, 2007; 2008) including requirements for smaller charge

sizes, secondary loop systems, and energy efficiency measures such as high efficiency compressor designs, floating head pressure controls, heat recovery, ambient or mechanical subcooling, variable speed fans/motors, improved heat exchangers, hot gas defrost, anti-sweat heaters, LED lighting, and enclosed efficient display cases.

Staff requests comment on the following regulatory approaches to minimize refrigerant emissions in new supermarkets, food manufacturing/processing plants, and refrigerated warehouses:

1. Require compliance with ASHRAE Standard 147

The new ASHRAE Standard 147 will set performance standards for new refrigeration and air-conditioning equipment and components and establish best practices for installation, servicing, and decommissioning. Staff proposes that at a minimum, this new standard be adopted for all stationary refrigeration and air-conditioning systems in California, both retrofits and new installations.

2. Smaller Charge Size in New Retail Food Stores

Under this option, companies that own or operate more than 3 retail food stores in California with annual sales in each of the stores greater than $5 million would be required to install best available refrigeration technologies in each new store for which construction starts on or after January 1, 2012. Best available refrigeration technologies would be defined as those technologies and strategies that reduce total refrigeration charge of an entire system to less than 1.75 pounds of high-GWP refrigerant per 1,000 Btu-hour.

This metric is intended to provide supermarkets with flexibility to install direct expansion, distributed, or secondary loop systems that have superior performance compared to current technologies. It is also intended to provide a level metric to compare performance across different store categories. The particular target of 1.75 pounds/Btu-hour is derived from calculation of the refrigerant charge per energy output for a typical supermarket in California today. Baseline data are from a final report to ARB by Clodic and colleagues at ARMINES who conducted a set of surveys of facilities with refrigeration and air conditioning equipment throughout the state in 2007 and 2008, including 58 supermarkets (ARMINES, 2008). In an average California grocery supermarket (47,360 sq ft), the cooling capacity (kW) of low and medium temperature centralized systems, and condensing units (stand alone units excluded) totals 388.2 kW. This is equivalent to an energy output rate of 1,325,000 Btu/hour. The total refrigerant charge contained within the equipment in a typical CA grocery store was calculated by summing the estimated total charge size contained within medium and low temperature centralized systems (3,035.76 lbs) and condensing units (124.56lbs). Stand-alone units (16.31lbs) were excluded. The total refrigerant charge size (3,160.32 lbs) was then divided by the estimated cooling

capacity (1,325,000 Btu/h) to yield the estimate of 2.385 lbs total refrigerant charge per 1,000 Btus per hour.

Staff is proposing that new facilities install systems that have a 25% smaller charge per energy output compared to current stores, which would be approximately 1.75 pounds per 1,000 Btu/hour.

3. Total Carbon Footprint for New Retail Food Stores

Under this option, companies that own or operate more than 3 retail food stores in California with annual sales in each of the stores greater than $5 million would be required to reduce the carbon footprint reduction in any new store for which construction starts on or after January 1, 2012, with a high-GWP-based refrigeration system containing over 50 pounds of refrigerant.

Total carbon footprint would be calculated as follows:

(REFRIG * GWP) + (ENRGY * $EFco_2$)

Where:
REFRIG = Total refrigerant capacity of all air-conditioning and refrigeration equipment contained in an average facility, within each facility category

GWP = Global Warming Potential of the refrigerant, based on the IPCC Fourth Assessment Report

ENRGY = Average annual energy consumption by an average facility, within each facility category (kWh/year)

EFco2 = Average CO_2 emissions rate for each AQMD (CO2 emissions/kWh)

The goal for carbon footprint reduction could be a percentage reduction from a baseline level, or it could be based on a model high efficiency/high performance store. The following summarizes the different approaches that could be taken to develop a carbon footprint reduction goal under this option.

a) Percentage Reduction From Baseline

Different categories of facilities could be identified. For example,

Supermarket (sq ft)	Mixed Use: Retail Food Superstores	Food Storage	Food Processing/Manufacturing
25,000-30,000	25,000-50,000	25,000-50,000	50,000-75,000
30,000-35,000	50,000-75,000	>50,000	>75,000
35,000-40,000	>75,000		
40,000-45,000			

45,000-50,000			
>50,0000			

For each category, ARB would identify a baseline total carbon footprint, based on data submitted by retailers. The regulation would specify a required percentage (e.g., 25%) reduction in the total carbon footprint for each category. Under this scenario, if the baseline total carbon footprint for a 40,000 square foot supermarket in a given air district is 100 metric tons of CO_2 equivalent ($MTCO_2E$), any new store in this category would be required to reduce its footprint to 75 tons of $MTCO_2E$.

b) Model Store(s)

For the different categories of facilities noted above, ARB would establish high efficiency/high performance criteria that new facilities would have to meet. ARB would collect data on advanced stores, either in existence or it could consider working with industry to commission construction and testing of a store that uses advanced technologies.

Any of the alternative approaches under the "total carbon footprint" option would involve energy analysis and potentially new categories of building energy standards. ARB is working with the California Energy Commission to examine these different approaches and gather input from the public.

4) Other Options

Staff is also considering limiting the total charge size for a refrigeration system in a new facility. As noted above, the centralized system in a typical supermarket in California has an average charge size in the range of 3,000 pounds. To prevent large releases associated with catastrophic leaks, one option is to establish a maximum charge size for a system of 2,000 pounds of high GWP refrigerant. This option could potentially prohibit new stores from using conventional direct expansion systems regardless of their leak rates or performance.

Another option is to link the new rule to the US EPA GreenChill Advanced Refrigeration Partnership. GreenChill is an alliance with the supermarket industry and other stakeholders to promote advanced technologies, strategies, and practices that reduce refrigerant charges and emissions of ozone-depleting substances and greenhouse gases, and increase refrigeration system energy efficiency (www.epa.gov/Ozone/partnerships/greenchill/index.html).

The initial phase of the GreenChill Advanced Refrigeration Technology Standards is under development, and like the new ASHRAE Standard 147, is expected to be established in 2009. The standards will include limits for leak rates from new and operating systems and HFC refrigerant charge, possibly based on pounds of refrigerant per BTU of energy output.

Discussion

The various approaches outlined above seek to promote advanced technologies and practices in existing systems, and in new supermarkets and other retail and industrial food facilities. There are a number of issues that arise in the approaches, including:

- Reliance on a standard that is being revised (ASHRAE 147).
- Expanding the scope of the regulations beyond strictly high-GWP refrigerant containment to include energy efficiency.
- Prescribing specific technical standards (e.g., high refrigerant charge below 1.75 pounds per 1000 Btus/hour per system in new supermarkets) could unnecessarily limit options to achieve optimal performance and minimal emissions.
- Applying requirements to only larger companies with multiple stores in a given air district could result in an unlevel playing field and preventable emissions if smaller companies are allowed to install lower-quality or lower-performance technologies.
- Under the total carbon footprint option, compliance would be partially based on whole store energy performance after the store was fully operational. If the store was not able to meet the carbon footprint reduction goal, it could have a difficult time making post-construction design and infrastructure changes to its refrigeration system, lighting, HVAC system, etc.

Questions regarding options

- Should ARB specify standards for new equipment installations, or should it rely on advances within the industry that are underway motivated by rising energy and refrigerant costs?
- Does reliance on ASHRAE Standard 147 create too many uncertainties given that it is being developed by industry and likely won't be updated until 2009?
- Does reliance on GreenChill Advanced Refrigeration Technology Standards create different uncertainties given that they won't be developed until 2009?
- Should specifications for commercial refrigeration equipment in new, large (25,000 sq ft) facilities be restricted to retail food stores, refrigerated warehouses, and food processors/manufacturers or should there be other types of facilities included? Should these categories be more restricted, for example, only applied to large supermarkets, owned or operated by companies with more than 10 stores in California?
- Would specifications for new supermarkets and other commercial food facilities create unfair advantages to other businesses that use refrigeration and air-conditioning equipment? Unfair advantages to stores and food processors in other States?

- Is the definition of BART (1.75 pounds of high GWP refrigerant per 1000 Btus per hour) reasonable for a new California supermarket? If not, what would be a better number?
- Should ARB specify a maximum high-GWP refrigerant charge for a system to minimize risks associated with catastrophic events that discharge all of the refrigerant in a system? If so, what would be an appropriate maximum charge size be to encourage the use of more advanced, efficient technologies?
- Do the options for total carbon footprint reductions provide sufficient flexibility for new stores to design their buildings and operations to take advantage of multiple technology advances?

References will be listed in a subsequent draft that will be posted on the web.